A Statistical Analysis of Par

For Open Players

On the Fountain Hills Championship Course

At the 28th Memorial Championship presented by Discraft

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Preview

An analysis of the scores of the Open Players can provide information which can be used to set pars which best enhance the player and spectator experience.

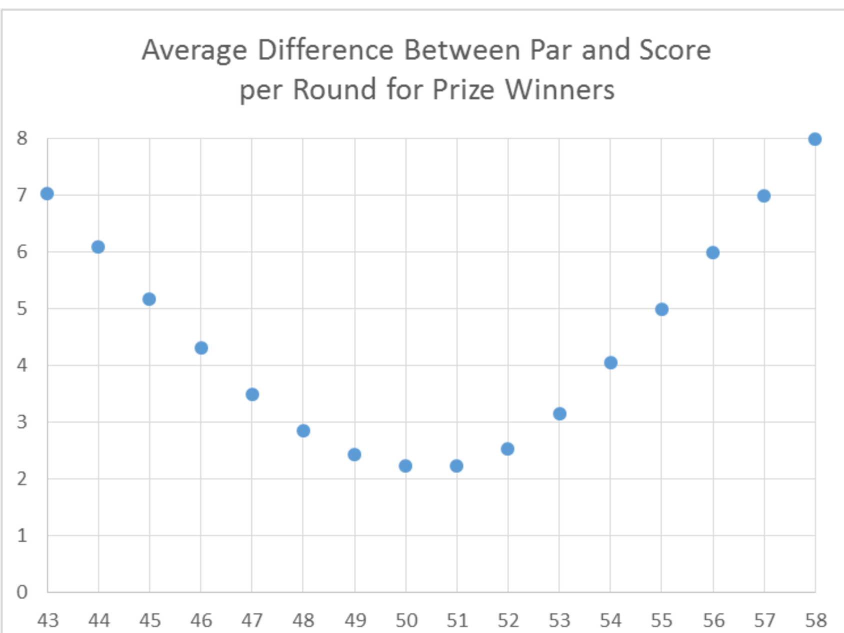
A good par will let a player know how they are doing relative to the players that are in contention for prizes. Ideally, getting a birdie would mean that the player moved up in the rankings, and getting a bogey would mean the player moved down by the same amount.

Also, total par for the tournament is most helpful when the differences between par and the actual scores are minimized across all players who win prizes.

Total Par for Fountain Hills

The average score on the Fountain Hills Championship Course for all the prize winners was just over 50. This would not be a bad good choice for total par.

Measuring more directly, we can compute the average deviation of scores from par per round for all prize winners, for each possible par. Following is a plot of deviations as a function of par.



On this graph, lower dots are better. If par were set to 50 or 51, the differences between par and scores would be minimized at just over 2 throws per round. This is the ideal par, in the sense that players get the most information about their performance relative to this par, because par would be as close as possible to what the prize winners are scoring.

Developing Hole Pars from Scoring Data

Par is errorless play by an expert disc golfer. First, let's determine the expert.

Expert Player

Using a prototypical 1000-rated player is preferable for the following reasons:

> 1000 is a nice round number which is easily remembered by spectators
>
> 1000 was set to be about the skill level required to win a prize in open.
>
> A score equal to the ideal pars would be rated slightly above 1000. This is consistent with errorless play by a 1000-rated player, because they make an unrecoverable mistake or two per round.

The prototypical 1000-rated player can be represented by an average across a group of players with an average rating of 1000. This could be done by choosing a set of players with an average rating of 1000.

Even better is a bell-curve shaped weighted average so that we wouldn't need to include a 945 rated player to balance out the 1055 rated player.

By taking weighted averages of the scores reported on the Hole-by-hole scoring on the PDGA site, we can develop the following scoring distributions:

Percent of 1000-rated players that get each score.

	1&2	3	4	5+
1	25%	59%	14%	2%
2	0%	56%	36%	9%
3	75%	21%	4%	0%
4	23%	66%	10%	0%
5	44%	45%	9%	2%
6	71%	22%	7%	0%
7	57%	34%	9%	0%
8	0%	74%	15%	11%
9	5%	67%	27%	1%
10	52%	43%	5%	0%
11	43%	54%	2%	1%
12	65%	35%	0%	0%
13	72%	24%	4%	0%
14	56%	39%	6%	0%
15	40%	57%	3%	0%
16	59%	37%	3%	0%
17	35%	64%	0%	0%
18	16%	67%	15%	2%

When setting par, what really matters is how many players scored each score or better, so we need the cumulative scoring distribution, as follows.

Percent of 1000-rated players that get each score or better.

	<=2	<=3	<=4	<=5
1	25%	84%	98%	100%
2	0%	56%	91%	100%
3	75%	96%	100%	100%
4	23%	89%	100%	100%
5	44%	89%	98%	100%
6	71%	93%	100%	100%
7	57%	91%	100%	100%
8	0%	74%	89%	100%
9	5%	72%	99%	100%
10	52%	95%	100%	100%
11	43%	97%	99%	100%
12	65%	100%	100%	100%
13	72%	96%	100%	100%
14	56%	94%	100%	100%
15	40%	97%	100%	100%
16	59%	97%	100%	100%
17	35%	100%	100%	100%
18	16%	83%	98%	100%

We could use these to set par by choosing a cutoff percentage. Let's use 60% as an example. Par is the lowest score that at least 60% of the players scored.

However, there is another way which is even closer to the definition of par. Notice that to achieve a score equal to par 3, the player needs to string together 3 errorless throws. But, to achieve a par 2 the player only needs two errorless throws in a row.

The 72% of players who got a 3 on hole 9 performed better than the 72% of players that got a 2 on hole 13. The reason is that they needed to have all their throws be in the top 90% of 1000-rated throws, while to get a 2 on 13, they only needed their throws to be in the top 85%.

By simply taking the nth root of the above percentages (where n is the score), we can find how good the throws needed to be.

Top X Percentile Throws Needed to Get Each Score

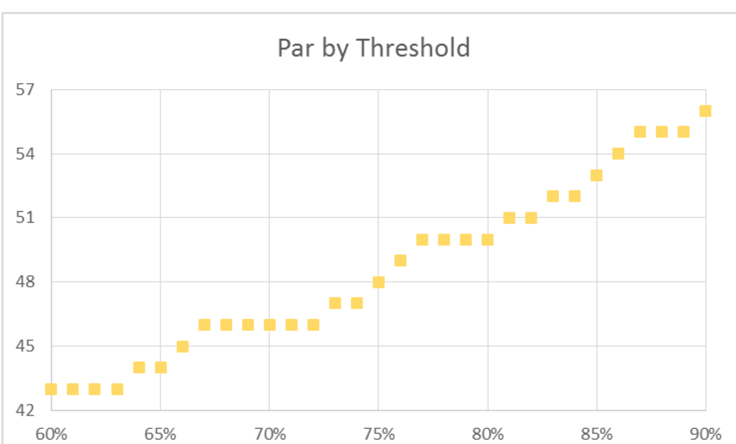
	<=2	<=3	<=4	<=5
1	50%	94%	99%	100%
2	0%	82%	98%	100%
3	87%	99%	100%	100%
4	48%	96%	100%	100%
5	66%	96%	100%	100%
6	84%	97%	100%	100%
7	75%	97%	100%	100%
8	0%	90%	97%	100%
9	23%	90%	100%	100%
10	72%	98%	100%	100%
11	66%	99%	100%	100%
12	80%	100%	100%	100%
13	85%	99%	100%	100%
14	75%	98%	100%	100%
15	63%	99%	100%	100%
16	77%	99%	100%	100%
17	59%	100%	100%	100%
18	41%	94%	100%	100%

This table shows the percent of throws that were good enough to get each score. For example, only the top half of all throws were good enough to get a 2 on hole 1. Because players needed to put together two top-half throws in a row, only 25% of 1000-rated players got a 2 on hole 1.

Now, we can pick a percentage for a cutoff threshold, and get consistently tough pars from hole to hole. The threshold represents how well the 1000-rated player needs to play to get the toughest par in the course.

The lower the threshold, the fewer the throws we are calling errorless, and the tougher the pars. Typical threshold are between 70% and 80%, but the exact number depends on how many opportunities for error the course presents.

Following is a chart of total par for the course by threshold.



We can use the above chart to find the threshold that gives us the ideal total par.

Earlier, we found that total par of 50 or 51 would be ideal. So, we could choose a threshold anywhere from 77% to 82%. Because par of 50 has a wider range of thresholds, it is more stable in some sense.

I chose to use 79% as the threshold. The resulting pars by hole are as follows:

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Par	3	3	2	3	3	2	3	3	3	3	3	2	2	3	3	3	3	3

Relative Toughness

The 79% threshold means that, for a 1000-rated player on the toughest hole to par (Hole 12, par 2) about one out of 5 throws are not good enough to result in par. By contrast, on the easiest hole to par (Hole 17, par 3) only one in 650 throws are not good enough for par. For the course overall, about one in 14 throws are not good enough for par.

We can compute the toughness of each hole by looking at the percent of throws that were good enough to get par and compare this to the threshold. If the percentage is close to the threshold, the hole was close to having a higher par. The closer the percentage is to 100%, the farther the hole is from being set to a higher par.

If we add the toughness fraction to the par, we can get an "exact par".

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Exact Par	3.3	3.8	2.6	3.2	3.2	2.8	3.1	3.5	3.5	3.1	3.0	2.9	2.7	3.1	3.0	3.1	3.0	3.3

This is useful for making manual adjustments. For example, we know par 51 is as good as 50, so we could change hole 2 to par 4 just to say we have one. Or change hole 12 to a par 3.

Uncertainty

Because the amount of date was limited, we need to account for statistical fluctuation. By computing the 80% confidence intervals around the observed percentages of player who go each score or better, we can come up with a likely range of exact pars.

Hole	Exact Par Range		
1	3.1	to	3.5
2	3.6	to	4.2
3	2.4	to	2.9
4	3.1	to	3.3
5	3.1	to	3.3
6	2.5	to	3.3
7	2.8	to	3.3
8	3.3	to	3.7
9	3.3	to	3.7
10	3.0	to	3.2
11	3.0	to	3.2
12	2.6	to	3.1
13	2.5	to	3.2
14	2.9	to	3.2
15	3.0	to	3.2
16	2.8	to	3.2
17	3.0	to	3.1
18	3.2	to	3.5

These ranges give some latitude for adjusting par. However, the ideal total par was based on all scores of all prize winners and is therefore likely to be quite accurate. So, any adjustments to par should be made with an eye to keeping total par around 50 or 51.

My choice would be to set holes 3, 6, 12, and 13 to par 3, and hole 2 to par 4, with the rest 3s.

Interestingly, even though hole 7 is the shortest, it is not a leading candidate to be a par 2.

Advanced Par

Using the same data, we can compute pars for Advanced players by using the prototypical 950-rated player. The result is the following ranges.

Blue Exact Par

Hole	Lo	Best	Hi
1	3.5	3.8	4.3
2	4.3	4.5	4.8
3	3.0	3.1	3.3
4	3.2	3.3	3.6
5	3.2	3.4	3.7
6	3.2	3.3	3.6
7	3.2	3.4	3.7
8	4.0	4.4	4.6
9	3.6	3.9	4.2
10	3.2	3.4	3.6
11	3.1	3.1	3.3
12	3.0	3.0	3.1
13	3.0	3.1	3.2
14	3.1	3.2	3.4
15	3.2	3.4	3.7
16	3.0	3.0	3.1
17	3.0	3.1	3.3
18	3.3	3.5	3.8

The best estimate (truncated) matches the tournament pars.

Conclusion

The Open division would be better served by pars that total 50 or 51, because there would have been less need to guess how many under par would win or cash. 50 or 51 could have been achieved with 4 or 5 par 2s, and at most one par 4.

If par had been set using this method for all 3 courses:

The winning par would have been a more credible 23 under instead of 45 under.

Last cash would have been 9 over instead of 13 under.

The average prize winning player would have been 2 under par instead of 24 under.

A score of even par would have been rated about 996 instead of about 955.